U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2016 WINNER *Housing Innovation Awards*

Insulsteel Building Enclosures

Sonny Boy Lane House
Johns Island, SC

BUILDER PROFILE

Insulsteel Building Enclosures, Charleston, SC
Tina Bostic, tina@insulsteel.com
843-637-4311, www.insulsteel.com
Rater: Coastal Training Consultants
Robert Bolus
rbolus@coastaltrainingconsultants.com

FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Sonny Boy Lane House
- Location: Johns Island, SC
- Layout: 5 bdrm, 5 bath, 2 fl, 3,756 ft²
- Climate Zone: IECC 3A, hot-humid
- Completion: April 2016
- Category: custom for buyer

Modeled Performance Data:

- HERS Index: without PV 50, with PV 12
- Projected Annual Energy Costs: without PV $2,347, with PV $643
- Projected Annual Energy Cost Savings (vs home built to 2012 IECC): without PV $2,348, with PV $4,042
- Projected Annual Energy Savings: without PV 18,174 kWh, with PV 38,329 kWh
- Added Construction Cost: without PV $35,000, with PV $40,000

When a rare tornado touched down on Johns Island on the coast of South Carolina, all of the homes in its path sustained considerable damage except for one–a two-story, 3,756-ft² custom home built by Insulsteel of South Carolina, LLC, to the criteria of the U.S. Department of Energy's Zero Energy Ready Home program.

Insulsteel's founders, Tina and Steve Bostic of Charleston, South Carolina, constructed the home using their "EcoShell Building Enclosure" design with structural insulated panels (SIPs) for a draft-free, highly insulated structure so sturdy that it can reportedly withstand 200-mph winds. The home was recognized by DOE with a 2016 Housing Innovation Award. It was the second DOE award winner for the Bostics. They'd won a 2014 Housing Innovation Award for another custom home under their Amerisips Homes label. Both homes were certified to the DOE Zero Energy Ready Home program.

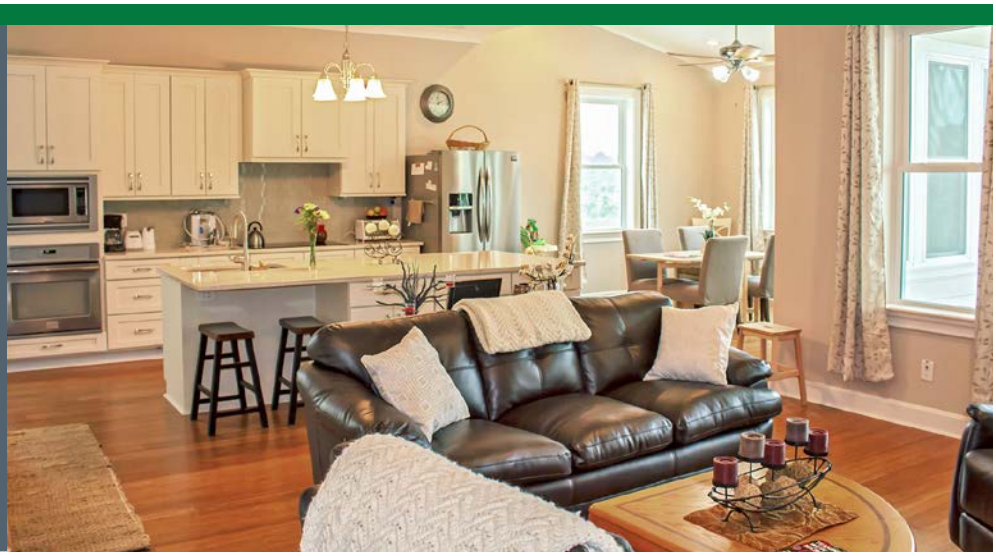
The DOE Zero Energy Ready Home program requires that every home be certified through ENERGY STAR Certified Homes Version 3.0 and the U.S. Environmental Protection Agency's Indoor airPLUS program. Homes must meet the hot water distribution requirements of the EPA's WaterSense program and the insulation requirements of the 2012 International Energy Conservation Code. In addition, the homes are required to have solar electric panels installed or have the conduit and electrical panel space in place for future photovoltaic panel installation.

Insulsteel installed 6.8 kW of photovoltaic solar panels and solar thermal water heating panels on the roof of the 2016 home. With these renewable-energy features, the home achieved a Home Energy Rating System (HERS) score of 12 and energy costs were an estimated $643 per year or about $54 per month. Even without the solar PV and water heating, the home achieves a HERS score of 50; most code-built homes in the United States would score between 80 and 100.

ZERO ENERGY READY HOME U.S. DEPARTMENT OF ENERGY

The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE's Zero Energy Ready Home program (formerly known as Challenge Home). Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0 for an energy-efficient home built on a solid foundation of building science research. Advanced technologies are designed in to give you superior construction, durability, and comfort; healthy indoor air; high-performance HVAC, lighting, and appliances; and solar-ready components for low or no utility bills in a quality home that will last for generations to come.

Insulsteel Building Enclosures built this 3,700-ft² home on Johns Island, South Carolina, to the performance criteria of the DOE Zero Energy Ready Home (ZERH) program. The home is certified to EPA Indoor airPLUS and LEED platinum. It has ENERGY STAR appliances, LED lighting, WaterSense plumbing fixtures, an Internet-controllable smart thermostat, and accessible features for aging in place.



What makes a home a DOE ZERO ENERGY READY HOME?

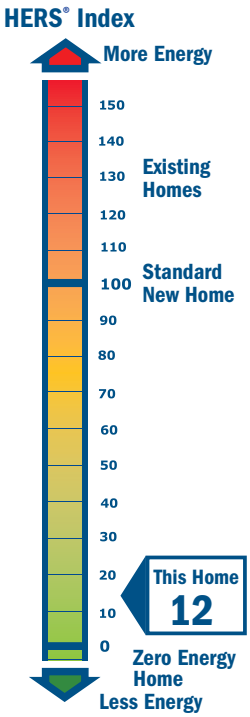
1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0

2 **ENVELOPE**
meets or exceeds 2012 IECC levels

3 **DUCT SYSTEM**
located within the home's thermal boundary

4 **WATER EFFICIENCY**
meets or exceeds the EPA WaterSense Section 3.3 specs

5 **LIGHTING AND APPLIANCES**
ENERGY STAR qualified



6 **INDOOR AIR QUALITY**
meets or exceeds the EPA Indoor airPLUS Verification Checklist

7 **RENEWABLE READY**
meets EPA Renewable Energy-Ready Home.

To achieve this high level of performance, Bostic chose magnesium oxide (MGO) SIPs to construct the walls and roof deck. The panels consist of two 12-millimeter-thick layers of magnesium oxide sandwiching an 8-inch layer of expanded polystyrene (EPS) for an R-value of R-33. The Bostics found that MGO panels have a superior fire rating to OSB or fiber cement panels, are highly resistant to moisture absorption, and do not support mold growth. The SIP walls were covered on the inside with drywall and on the outside with house wrap and fiber cement cladding. The roof panels were covered with 30# felt and standing-seam metal roofing in a white color to minimize solar heat gain. The SIP roof panels provide cathedral ceilings and insulated attics with increased fire and storm resistance as there are no soffit vents to provide entry for sparks or wind-driven rain.

Due to the coastal, hurricane-prone location, the builders used an elevated concrete block foundation as required by local code. The concrete walls were constructed with smart vents that allow water to flow through in the event of flooding. The first floor was insulated with 3 inches (R-19) of closed-cell spray foam that was sprayed on the underside of the subfloor to insulate and provide comprehensive air sealing protection from the garage below.

The SIP solid panel construction minimizes the opportunities for air leakage. The thick beads of construction adhesive used to glue the panels together and to the top and bottom plates also serve as an air sealant. Roof panel seams were taped. Subfloor seams were caulked. Flashing was installed around all doors and windows. These air-sealing measures helped to provide for an airtight home.

The home was heated and cooled with an air-to-water heat pump. The system uses a variable-speed compressor that can adjust speed based on temperature and heating loads for greater efficiency. The heat pump pulls heat from or sheds heat to the outside air via a refrigerant loop that circulates refrigerant from the outside compressor to a hydrobox located in the conditioned attic. The hydrobox heats or cools water that circulates through coils in the air handling unit to heat or cool air blown through the unit. The base efficiency of the heat pump is an EER of 9.33 and a COP of 3.81.

The air handler distributes conditioned air throughout the home via small-diameter, high-velocity ducts. The main trunk lines for the system were located in the attic spaces and the smaller ducts were run within the open-web floor joists

The walls are constructed with magnesium oxide panels that are fire resistant and capable of withstanding 200 mph winds. These panels plus insulation and house wrap provide a total wall insulation value of R-33. Disaster-resistant construction includes a raised concrete foundation that keeps the living space above floodwaters. The home's windows are impact-resistant, double-hung, vinyl-framed, ENERGY STAR-rated double-paned windows with low-emissivity coatings and an argon gas fill between the panes to minimize heat transfer.

between the floors. The ducts came pre-insulated at R-3.3 for branch lines and R-8 for trunk lines. All ducts were sealed with tape and mastic, or gaskets for branch lines, prior to insulating them.

For ventilation, fresh outside air is brought into the home via an outside air vent with an automatically controlled actuated damper. The outside air is brought into the return plenum of the air handler and travels through a MERV 13 filter, through an ultraviolet light filter, and across the cooling and heating coils of the air handler to be conditioned before it reaches the air supply of the home. The air handler is electronically controlled to operate with the outside air intake to meet ASHRAE 62.2 ventilation requirements but excessive air handler run time can be minimized by choosing a setting that maximizes outdoor air damper opening periods within times when the system is operating for normal heating or cooling. Exhaust fans in the kitchen and bathrooms provide spot ventilation.

The home's primary hot water source is a solar water heating system that uses solar thermal panels mounted on the roof to heat a water-glycol fluid, which heats an 80-gallon storage tank via a heat exchanger. The solar panel pump controller is interlocked with a supplemental solar pump for the air-to-water heat pump. When there is a temperature difference of >18°F and the tank is not at maximum temperature, the solar pumps will run in unison with fractional horsepower pumps to create hot water at a much better efficiency than gas, electrical, or heat pump energy can produce. The air-to-water heat pump serves as a secondary heat source for the 80-gallon tank using heat pulled from the outside air via the refrigerant loop. The tank also has an electrical element in the unlikely event backup heat is needed.

The home owners were also very interested in water collection for gardening so the builder installed roof gutters over the front of the home that route water run-off to a 1,335-gallon cistern, which is used for drip irrigation. Gutters on the back roof direct water to six rain barrels. From there, PVC pipes carry the water to backyard gardens. One more rain barrel is located below the air condenser and leads to gardens on the west side of the house. A rain garden and a French drain next to the driveway catch and disperse additional runoff.

On the roof top is 6.8 kW of solar photovoltaic panels. The 427-ft² array is tilted at an optimal angle of 22 degrees south and the panels operate at 96% efficiency. The system was set up to be grid-tied; but it can also be switched to power a

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program, 100% commitment

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

LEED for Homes, platinum

ENERGY STAR

Building AMERICA U.S. Department of Energy

Every DOE Zero Energy Ready Home combines a building science baseline specified by ENERGY STAR Certified Homes with advanced technologies and practices from DOE's Building America research program.

The air-to-water heat pump is installed within the conditioned space of the insulated attic.

subpanel of critical backup circuits while lithium ion batteries provide 200 Amps of standby power "off the grid" during emergencies.

Steve and Tina Bostic began building homes in the Charleston, South Carolina, area in 2011. Their desire to find a better way to build led them to MGO SIPs. After constructing two homes with MGO SIPs, including this 2016 award winner, they discovered insulated steel panels. These consist of solid panels of expanded polystyrene (EPS) with reinforcing steel C-channel posts spaced at 16 inches on-center that serve as nailing surfaces for the panels, which are typically 4x12 feet and come in widths varying from 5.5 to 9.5 inches thick. Because the steel strips are fused into the outer surface of the panels but do not extend through the panels, there is no thermal bridging through the panels, so they can provide insulation values of up to R-40 to R-58. The Bostics were so certain of the product's potential that they founded Insulsteel™ Building Enclosures and its parent company Insulsteel of South Carolina, LLC, in 2015 to manufacture the EPS and steel panels.

They have since designed 12 homes with the Insulsteel panels through their Amerisips Insulsteel Homes custom home construction company, including three homes that are or will be certified to the DOE Zero Energy Ready Home specifications.

Insulsteel promotes the "EcoShell" system that is used in their own homes and can be used by other builders who buy Insulsteel panels. "We market the Insulsteel "Free Energy Living®" home building process, which includes our systems, DOE and LEED certification, indoor air quality design for a healthy home indoor environment, and a home owners' warranty program," said Steve Bostic. Insulsteel also uses its Free Energy Living® mortgage estimator to show potential home buyers how the energy savings they will reap can offset added costs to meet their monthly mortgage budget while yielding an exceptionally efficient home.

In addition to the high energy efficiency features, the system also incorporates building durability features like a design that can withstand 200 mph winds, water- and pest-resistant wall and roof panels with a two-hour fire rating, unvented attics, durable metal roofing, impact-resistant glass, elevated floors, solar water heating, and solar PV that is wired with battery backup for stand-by power. All of these features add up to a home that can handle whatever weather hits the southeastern seaboard, from high winds and hurricanes to coastal flooding and even the occasional tornado.

Photos courtesy of Insulsteel Building Enclosures

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance.
- **Walls:** R-33 5.5″ EPS + steel insulated panels, OSB sheathing, house wrap, fiber cement siding.
- **Roof:** R-33 5.5″ EPS + steel insulated panels, OSB decking, architectural shingles.
- **Attic:** Unvented, R-33 EPS panels.
- **Foundation:** Raised-pier foundation, 2.75″ spray foam under floor.
- **Windows:** Vinyl-framed, double-hung, double-pane, low-e, argon-fill, U=0.19-0.30, SHGC=0.19.
- **Air Sealing:** 3.3 ACH 50.
- **Ventilation:** Fresh air intake to air handler, electronic damper-controlled, MERV 13 filter.
- **HVAC:** Air source heat pump, EER 8.65, HSPF 7.25; small-diameter high-velocity ducts in conditioned attic.
- **Hot Water:** Solar hot water and electric hot water to two 40-gal tanks.
- **Lighting:** All LED fixtures.
- **Appliances:** ENERGY STAR refrigerator, dishwasher.
- **Solar:** 6.8-kW with battery backup; solar hot water.
- **Water Conservation:** WaterSense fixtures.
- **Energy Management System:** Electronic thermostats.
- **Other:** No-VOC paints & sealants.

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